

USB Telephony Devices: Interfaces for Value Add Feature Sets

Revision 1.1

November 20, 2000

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1 Introduction

As IP telephony is developed and dispersed, the PC will play a greater role in personal communications. IP telephony is already being used as a replacement for the standard Public Switched Telephone Network (PSTN) for placing some long distance and international calls. Web sites are being deployed with “click-to-talk” capabilities, which allow a customer to establish an IP voice connection with a vendor through their PC. The ability to use natural language to interact with network-based resources also requires voice over IP from the desktop. One of the current limiting factors blocking wider acceptance of voice over IP is the lack of a dedicated voice device or voice terminal for the PC. Users are not comfortable using the desktop speakers and microphone for voice over IP interactions. These devices present several problems for use with voice over IP, including privacy issues and echo cancellation. The telephone handset or headset is clearly the preferred user device for voice communications.

This paper presents several examples of voice over IP capable handsets. All models use Universal Serial Bus (USB) as the means of connecting the handset to the PC. USB is preferred because it is a “discoverable” bus. It allows the PC to enumerate all the capabilities of the handset and thereby tailor the user experience to the handset. The USB Device Working Group (DWG) has spent a great deal of effort in developing specifications for USB devices and this paper uses these specifications in describing the interfaces used by these devices.

The paper starts by describing a basic USB handset. This is a simple device and as such, will probably quickly become a commodity device. Because of its simplicity, vendors will want to develop value-add features to allow them to differentiate their device from others. To address this, this paper provides examples that show how to add features to the basic handset to develop a value-add device. Such features include speakerphone capabilities, PSTN connections, text displays, and high-fidelity audio.

1.1 *General Notes on the Models*

This section lists some general notes that apply to all the models described in this paper.

1.1.1 Operating System Support

Not all current versions of popular operating systems support all the devices described in this paper. USB telephony devices are just starting to appear and operating systems are being modified in order to deal correctly with them. All the devices described in this paper follow USB DWG class specifications. As such, they are likely to be fully supported in future versions of these operating systems.

1.1.2 Serial Numbers

The use of serial numbers in USB telephony devices is optional but recommended. Serial numbers allow the PC to track specific devices and their settings.

1.1.3 Sample Sizes and Sample Rates

All models in this paper use 16-bit signed PCM format samples. This size and format is widely supported by audio silicon and is easily processed by the host audio stack. The models also support two sample rates, 8kHz and 16kHz (listed as the desired or optimal sample rate). This rate allows for capturing and rendering audio frequencies up to 8kHz, so that the devices described here meet or exceed the audio quality levels of a standard PSTN telephone. Phone designers can add support for higher sample rates to achieve better audio quality. See Section 9 for details.

1.1.4 Isochronous Endpoint Transfer Size

All models in this paper use an isochronous endpoint transfer size one sample larger than the calculated size to allow for rate-adaptive endpoints.

1.1.5 Hook Switch

All USB telephony devices should contain a HID interface that supports a HID-compliant hook-switch. This provides operating systems with an indication that the device is a telephony device and not a preferred system audio device. This control must be implemented as an On-Off control as per the HID Usage Tables, Section 3.4.1. The HID report value corresponding to the hook-switch must contain a '1' when the phone is "off-hook" and a '0' when the phone is "on-hook".

1.1.6 Silicon Capabilities

The devices described here must be capable of bi-directional full-duplex audio. *Bi-directional* means that they can capture audio from a microphone and render audio to a speaker. *Full-duplex* means that they can perform both capture and render operations at the same time.

1.1.7 Device Localization

In general, only HID keyboards support localization. The devices described in this paper are not localized for any particular country. Localization does not apply to a telephony keypad, but can apply to a text display on a telephone. If text display localization is required, it is the responsibility of the host software to provide this support, either through character mapping or font downloading. This can be further complicated by features such as caller ID, where some of the value-add text can come from the originator.

1.1.8 Bus-Power and Remote Wakeup

The devices listed in this paper support remote wakeup, allowing the device to wake the host computer if the user places the device in an *off-hook* state.

The devices described in this paper, with the exception of the PSTN-equipped model, derive their power from the USB bus.

Any bus-powered device must describe its maximum power consumption in the *bMaxPower* field in the Configuration Descriptor. The examples listed in this paper list this value as 100mA. (1 unit-load), the maximum power that a device behind a bus-powered hub can draw. This value is for illustration only and must be adjusted for an actual implementation.

1.1.9 Volume Controls

The devices described in this paper provide volume control for the speaker only. Microphones are only equipped with a mute control. Some existing applications will not recognize a microphone that does not have a mute control, preventing the application from working with the device. The HID Telephony Usages define a Phone Mute control (usage 0x2F). This is the preferred control to use.

1.1.10 HID Controls

All HID controls must be completely separate from the audio and telephony functions that they are associated with. When a user activates a HID control, that action signals the user's intent to the PC. The PC then adjusts the device to reflect the user's intent. The HID control should not cause any device changes by itself.

1.1.11 HID Feature Reports

All HID on-off controls (OOC) and momentary controls (MC) that are present in the device's HID Input report should also be present in a HID Feature report. This allows the system software to query the state of these controls when the system initializes the device. For instance, if a device without a HID feature report is plugged into the host while it is off-hook, the host may not detect the off-hook state until the next time the device goes off-hook. The feature report allows the host to determine that the phone is off-hook at initialization time.

1.1.12 Hardware Echo Cancellation

At the time of this revision, the USB Audio Device Class definitions only provide hardware AEC support for speakerphones. A speakerphone describes the presence of hardware echo cancellation by the choice of Terminal Type codes used in the Input Terminal and Output Terminal descriptors (see Section 3 and Table 1).

The USB Audio Device Class defines two types of hardware echo cancellation. These are half-duplex and full-duplex. Half-duplex operation works by disabling the speaker whenever the microphone input signal exceeds an arbitrary threshold. Since any room noise can contribute to the microphone signal level, this can result in the speaker signal being clipped by extraneous room noise. Full-duplex cancellation works by removing any traces of the speaker signal from the microphone signal. If hardware echo cancellation is present, the full-duplex operation is recommended because it is not subject to the speaker clipping and problems of half-duplex operation.

At the time of this revision, the USB Audio Device Class definitions do not provide any means for enabling or disabling echo cancellation. If echo cancellation is present, it must be assumed to be fully operational at all times.

1.1.13 Sidetone

Echo is generally thought of as an undesirable component of telephony. However, echo with a delay of 20 milliseconds or less is desirable and is referred to as sidetone. It is this echo that gives an end user the reassurance that the device is working. Devices without sidetone give users the impression of a “dead line”. In standard PSTN handsets, sidetone is usually generated by deliberately mismatching the circuits that separate the two-wire PSTN line into separate microphone and speaker components. This causes a small portion of the microphone signal to be coupled onto the speaker signal.

In USB handsets, the microphone and speaker streams are separate. This means that if a device is to generate sidetone, the special circuitry must be added to generate the sidetone. Sidetone cannot be generated on the host computer because the additional delay incurred will almost certainly be greater than the 20 millisecond allowable maximum.

Sidetone generation in the USB handset can be accomplished in several ways. The best method depends on the phone implementation. In any case, the microphone signal must be split and attenuated to a reasonable level and mixed into the speaker signal. Some codecs, such as AC’97 have topologies that can support sidetone generation, while others may require the addition of external circuitry.

The sidetone level is critical to the user experience. Users are accustomed to using this level as an indication of how well they are being heard by the other parties. They will adjust their voice level to compensate for a badly balanced sidetone, speaking quieter if the level is too high or speaking louder if the level is too low.

Sidetone generation is a recommended option. It should only be enabled on closed audio devices such as handsets and headsets. It should be disabled for speakerphone modes.

2 Basic Handset Model

This section describes a basic USB handset. The device consists of a handset microphone and speaker, a hook-switch or on/off button, and an optional keypad. Another example of this basic handset can be found in the Microsoft white paper, *Support for USB Telephony Device In Microsoft Windows**.

The audio topology for such a device is very simple. The USB OUT streaming endpoint is connected to the handset speaker and the handset microphone is connected to the USB IN streaming endpoint. The speaker has volume/mute control, indicated by the Feature Unit (ID 3). The microphone has mute control, indicated by the Feature Unit (ID 4). The host computer controls both Feature Units. Events generated by the hook-switch or the keypad are returned to the system by way of a USB IN interrupt endpoint. This interrupt endpoint belongs to a separate HID interface and as such, is not shown in the audio topology.

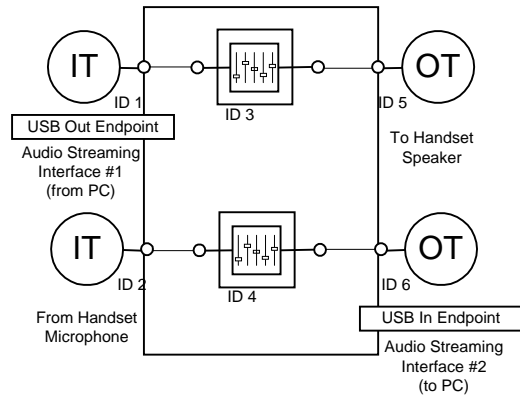


Figure 1: Basic Handset Audio Topology

2.1 Basic Handset Requests

The basic handset must support a number of standard USB requests. The standard requests are described in detail in Chapter 9 of the Universal Serial Bus Specification. At a minimum, the device must support the following standard requests.

- GET_DESCRIPTOR** - Used by the host to get descriptors from the device. The host can request device, configuration, string, and HID descriptors.
- SET_ADDRESS** - The host uses this request to assign a USB bus address to the device. This occurs once, early in the enumeration process.
- GET_CONFIGURATION** - Used to get the current configuration setting from the device. A configuration value of 0 indicates the device is unconfigured. Other values represent a 1-based index for the currently active configuration.
- SET_CONFIGURATION** - Used to set the current active configuration. A configuration value of 0 unconfigures the device. Other values select the configuration to activate.
- GET_INTERFACE** - Returns the currently selected alternate setting for the specified interface.
- SET_INTERFACE** - Selects the alternate setting to activate the specified interface.
- GET_STATUS** - Used to query the device for status. The request can be targeted to the device, an interface, or an endpoint. The meaning of the status depends on the target.
- CLEAR_FEATURE** - Used to disable remote wakeup or to clear an endpoint HALT condition.
- SET_FEATURE** - Used to enable remote wakeup or to place an endpoint into the HALT state.

In addition to the standard requests, the basic handset must also support the GET/SET Audio Control requests as detailed in Section 5. The target controls of these requests are the volume and mute controls in the two Feature Units as shown in Figure 1.

The device must also support the Audio Device Class Endpoint Sampling Frequency Control request. This request is sent to a streaming endpoint to set the current sampling rate for that endpoint. The output path on some devices may be rate-adaptive. These devices determine the current sampling rate from the number of samples they receive in one USB frame. Support of this command is not required by such endpoints.

The basic handset described above contains a volume control for the handset speaker level. The control can only be adjusted using the host computer. However, a HID volume control can be added to allow the user to control the volume from the handset. The following example illustrates the HID codes that should be added to the HID Report Descriptor to describe such a volume control

```
Usage (Handset)
Collection (Logical)
    UsagePage (Consumer Devices)
    Usage (Volume)
    Logical Minimum (-1)
    Logical Maximum (1)
    Report Size (2)
    Report Count (1)
    Input (Data, Var, Rel)
End Collection ()
```

3 Speakerphone

This section describes a simple handset/speakerphone device. The addition of the speakerphone capability requires the addition of a physical microphone and speaker, represented by Input Terminal (ID 2) and Output Terminal (ID 9). A switch (ID 4), referred to as a *Selector Unit* in the USB Audio Device Class Specification, is added to choose between the two microphones. As defined, a Selector Unit connects one of two or more input pins to a single output pin. Because of this, a Selector Unit cannot be used to choose between the two speakers since this usage requires a switch that connects a single input pin to one of several output pins. Instead, an additional Feature Unit (ID 6) is added so that each speaker has an associated volume and mute control. Speaker selection is then done by muting the speaker not selected.

One additional Feature Unit (ID7) is connected between the Selector Unit and Output Terminal (ID 10) to allow the speakerphone microphone to be muted. This Feature Unit should only contain a mute control. This Feature Unit could be placed on either the input side or the output side of the Selector Unit. In this example, it is placed on the output side because this configuration is representative of implementations using existing USB audio silicon. Such silicon provides internal volume and mute controls while the Selector Unit is implemented using an external switch.

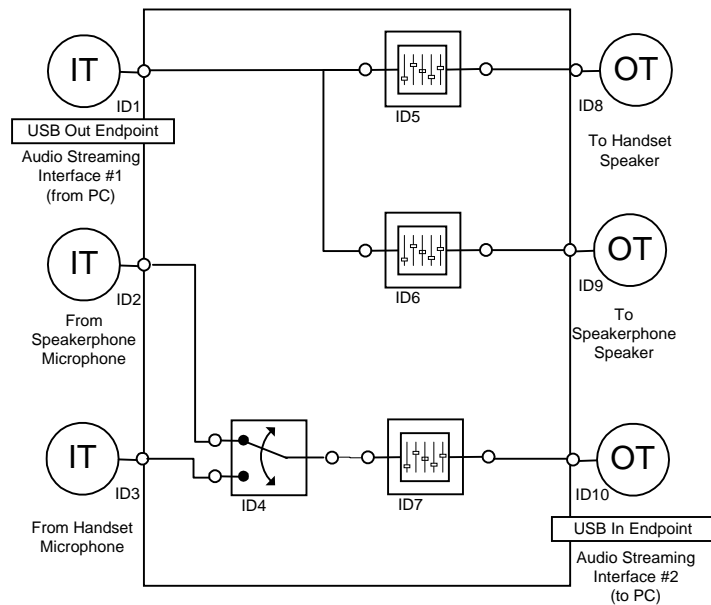


Figure 2: Speakerphone Audio Topology

Many speakerphones provide some degree of hardware echo suppression or cancellation. The Audio Device Class defines three different Terminal IDs for speakerphones. The ID indicates the level of echo cancellation to the host:

Terminal Type	Code	Description
Speakerphone, no echo reduction	0x0403	A hands-free audio device designed for host-based echo cancellation
Echo-suppression speakerphone	0x0404	A hands-free audio device with echo suppression capable of half-duplex operation – this type should not be used
Echo-canceling speakerphone	0x0405	A hands-free audio device with echo cancellation capable of full-duplex operation – this is the recommended type to use

Table 1: Speakerphone Terminal Types

To enable the user to select between the handset and the speakerphone, the HID Report Descriptor can be modified to include a HID Speakerphone button (Telephony Usage Page 0x0B, Usage ID 0x2B). This button is an On/Off control and is paired with an LED to provide button-state feedback to the user. The speakerphone button does not drive the LED directly. Instead, an application or driver on the host computer controls the LED state in response to the speakerphone button presses. The device informs the host computer of speakerphone button presses by including the button state in the device's HID report.

3.1 Speakerphone Requests

The speakerphone supports all the basic handset requests listed in Section 2.1. In addition, it supports class-specific Audio Control GET/SET requests targeted at the Selector Unit.

4 PSTN Support

The USB telephone models described to this point are really computer voice terminals. Connectivity between the devices requires a computer network such as the Internet. The device is primarily intended for Internet calls, but a separate telephone is required to make a standard PSTN call. The device presented in this section combines the two phones by adding a PSTN connection to the basic USB handset, thereby eliminating the need for two separate devices.

The device described in this section does not provide modem capabilities. The complexities involved in combining a USB modem with a USB handset are beyond the scope of this document.

From a USB standpoint, the addition of a PSTN connection to a USB handset represents the addition of a second bi-directional audio pipe for PSTN data and a Communications Device Class (CDC) control interface for call control. Physically, this requires two additional isochronous endpoints for the additional audio pipe and one endpoint for the CDC notification element. The CDC control interface overlays the control endpoints and as such, requires no additional endpoints beyond the notification element.

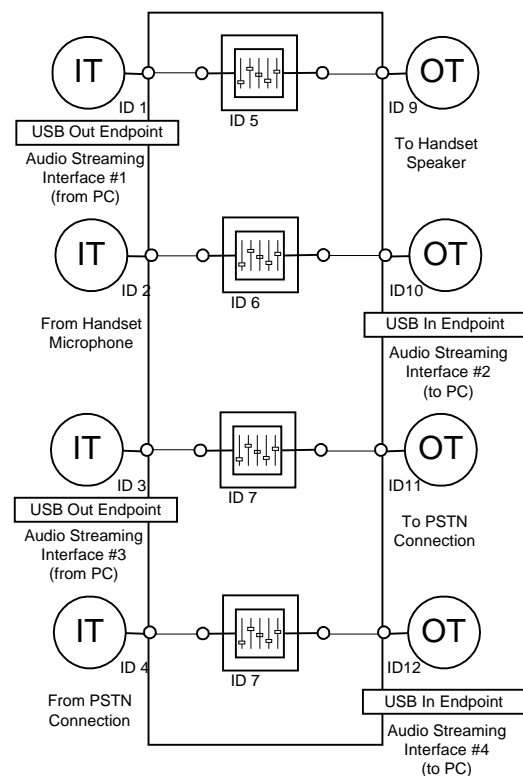


Figure 3: Audio Topology for a Basic Handset with a PSTN Connection

Figure 3 shows the USB Audio Device Class topology for a basic handset that has been extended to include a PSTN connection. In this simple model, both the handset audio and the PSTN audio are routed through the host computer. This type of device is really two logically separate bi-directional audio functions contained in a single device. The drawback to this type of device is that it requires the host computer be up and running in order to function. In some markets, this dependency on a host computer may be viewed as a significant drawback to the device.

The topology presented in Figure 4 further extends the device to provide a standalone configuration as well as the computer-centric configuration presented in Figure 3. Two Selector Units are added to enable a standalone mode by providing connections between the PSTN interface and the handset microphone and speaker. The selector units default to this standalone mode whenever the device is in the USB *un-configured* state or USB bus power cannot be sensed at the device. This behavior allows use of the telephone when the computer is turned off or the device is not connected to the computer.

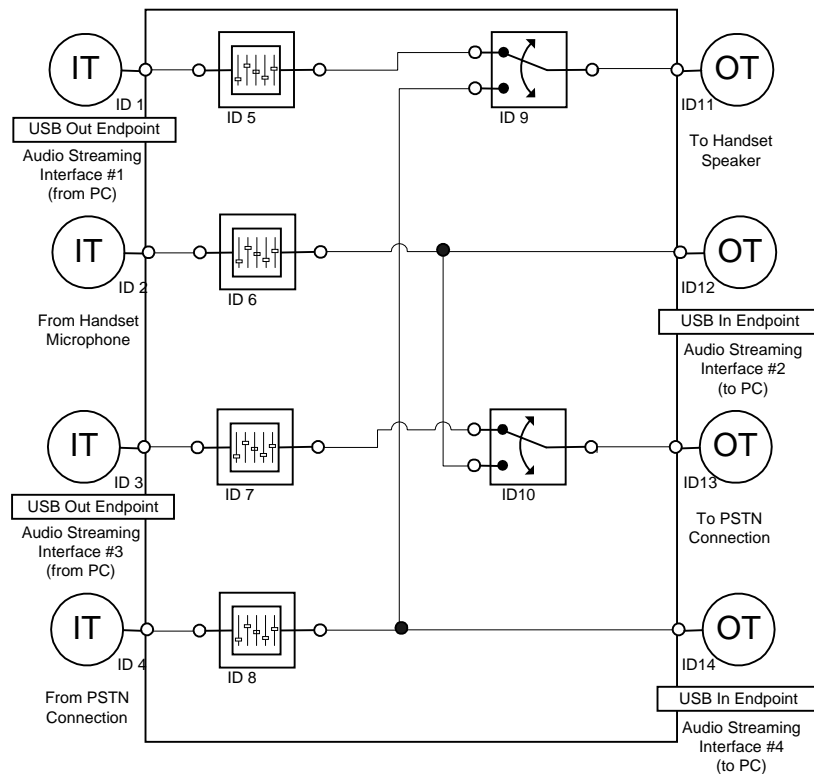


Figure 4: Audio Topology for a Standalone-Capable PSTN Phone

The CDC specification contains two models that can be used to add one or more PSTN connections to a USB telephone. The correct model to use depends on the device capabilities. The Direct-Line model requires the least of the device. It requires the use of a DAA and a CODEC to convert the connection to an isochronous data stream. It also requires that the device can control the hook-switch on command and provide incoming ring detection. The second model is the Telephone Control Model. This model places several additional requirements on the device. It is intended for devices where USB is added to the telephone, rather than devices where a PSTN connection is added to the

USB handset. This model requires that the device return call and line state information. It must be able to report idle, dial tone, dialing, connected, ringing, and answered states.

4.1 PSTN-enabled Phone Requests

The PSTN-enabled phone must support all the basic handset requests listed in Section 2.1. In addition, it must support class-specific Audio Control GET/SET requests targeted at the Selector Unit if a Selector Unit is used in the device.

The addition of PSTN also requires the device to support a subset of the requests defined in the CDC specification. The exact subset depends on the CDC model chosen for the device. The tables below list the required and optional requests applicable to each model.

Request	Required/Optional
SET_AUX_LINE_STATE	Optional
SET_HOOK_STATE	Required
PULSE_SETUP	Optional
SEND_PULSE	Optional
SET_PULSE_TIME	Optional
RING_AUX_JACK	Optional

Table 2: Direct Line Control Model Requests

Request	Required/Optional
SET_COMM_FEATURE	Optional
GET_COMM_FEATURE	Optional
CLEAR_COMM_FEATURE	Optional
SET_RINGER_PARAMS	Optional
GET_RINGER_PARAMS	Required
SET_OPERATIONAL_PARAMS	Optional
GET_OPERATIONS_PARAM	Optional
SET_LINE_PARAMS	Required
GET_LINE_PARAMS	Required
DIAL_DIGITS	Required

Table 3: Telephone Control Model Requests

4.2 PSTN-enabled Phone Notifications

CDC notifications are used to inform the host of asynchronous events on the device. These notifications are delivered to the host on the interrupt endpoint contained in the CDC Control Interface. The notifications that a particular device handles depend on the type of CDC control model implemented in the device. The following tables list the applicable notifications for each of the two control models.

Notification	Required/Optional
AUX_JACK_HOOK_STATE	Optional
RING_DETECT	Required

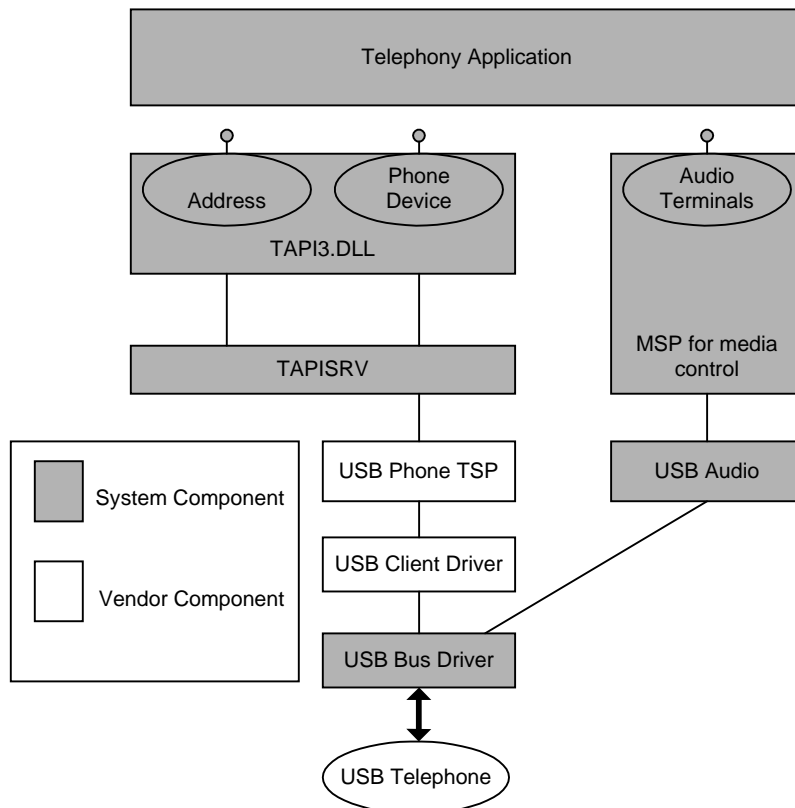
Table 4: Direct Line Control Model Notifications

Notification	Required/Optional
CALL_STATE_CHANGE	Required
LINE_STATE_CHANGE	Optional

Table 5: Telephone Control Model Notifications

4.3 Host Software Considerations

Microsoft does not currently provide any host driver support for USB-PSTN devices. As such, the device vendor must supply a USB client driver and a TAPI Service Provider (TSP) to operate the device. Details regarding TAPI and TSP development can be found in the Microsoft Platform SDK.

**Figure 5: PSTN Host Architecture**

4.4 Electrical Considerations

The addition of a PSTN connection can add considerable complexity to the electrical design of a USB telephone. PSTN uses electrical current (as opposed to voltage) to convey audio and signal information. In the United States, a PSTN connection supplies 48V DC with a guaranteed current level of at least 20mA. Elsewhere in the world, this DC voltage can be in the range of 30-60 volts. In addition to this DC, an AC ringing voltage in the range of 40-150 volts can also be present. The Central Office may also place other voltage and current levels on the line at any time for test and diagnostic purposes. Telephony standards recommend at least 1500V isolation between the PSTN connection and other electronics in the device.

Because the PSTN connection uses current for signaling, on-hook power consumption is a significant issue. In general, an on-hook device cannot consume more than 5 μ A of current. When a device is taken off-hook, the device can consume current. However the amount of current consumed must be minimized because excessive current consumption will result in lower signal levels.

5 Text Display

Text display is interesting for applications in both wireless handsets and desktop feature phones. Displays are used for PBX-like feature selection and programming and Caller-ID display. They are also used by telephony applications as the display component of a remote user-interface.

The HID specification provides usages for textual displays under the Alphanumeric Display Page (0x14). The capabilities defined allow for display control, cursor control, scrolling, font loading, and character transfers to and from the device. A good example of such a display implementation is found in Section A.8 of the *Universal Serial Bus HID Usage Tables V 1.1*.

If a text display is added to the device, the display should support downloadable fonts. The HID definitions for text displays provide a means for downloading fonts to the display. This capability allows telephony applications to localize the device to match the current locale settings of the host computer.

5.1 Text Display with Attributes

One drawback of the current Alphanumeric Display Page definitions is the lack of a means to apply emphasis to the displayed text. Such emphasis usually consists of underlining, emboldening, or reversed background and foreground colors applied to one or more of the displayed characters. Emphasis is used for many purposes such as indicating a current menu selection, differentiating title bars from selectable text, or creating regions on the display.

Intel has submitted a review request to the HID Device Working Group to address this problem. USBIF members can find the Review Request in the HID Device Working Group download area, titled HUT18.TXT. This review request has been approved by the HID Device Working Group and will be incorporated into the next revision of the HID Usage Tables. This revision is currently in progress and is available to USBIF members

in the same download area. The review request proposes the addition of the following usages to the Alphanumeric Display Page.

Usage Name	Usage Type	Usage ID
Character Attribute	CL	0x48
Attribute Readback	SF	0x49
Attribute Data	DV	0x4A
Char Attr Enhance	OOC	0x4B
Char Attr Underline	OOC	0x4C
Char Attr Blink	OOC	0x4D

Table 6: Proposed Alphanumeric Display Page Usage Additions

Character Attribute CL - The fields defined in this collection form a template that is used by Attribute Data reports to access the attributes associated with a character. The fields defined in this collection are treated as static by system software. Modifying the fields defined by this collection does affect the characters of the display; a Data Attribute must be used to do this. This collection consists of one or more of the following Char Attr usages.

Char Attr Enhance OOC - If 1, Enhance character, else display character normally, i.e. for a monochrome display, reverse all pixels in a character. Black pixels become white, white pixels become black. If 0, pixels in a character are displayed with their default.

Char Attr Underline OOC - If 1, Underline character, else no underline.

Char Attr Blink OCC - If 1, Blink character, else no blink.

Attribute Readback SF - Finding this usage in a display definition indicates that a Character Report containing Attribute Data usages can be read back. Otherwise, the display attributes are write-only.

Attribute Data DV - Writing to this field modifies the attribute values of the character at the current cursor position. When read, the attribute values of the character currently indicated by the cursor are returned.
This usage is always used in combination with a Display Data usage.
If this usage is declared, an Attribute Display collection must also be declared to define its contents. The Report Size of this field reflects the size of the data fields as defined in the Attribute Display collection.
If this usage is declared with a Report Count greater than 1, the attributes of multiple characters can be changed simultaneously, starting from the current cursor position. If the Attribute Readback

usage is declared, then the attributes of the characters from the current cursor position forward are returned when this report is read. If the range goes beyond the end of the display memory, zero data is returned.

The following Character Attributes collection defines a byte where bits 0, 1, and 2 define the Enhance, Underline, and Blink attributes that can be applied to a character. The remaining bits in the byte pad it to a byte boundary and are ignored by the display. Modifying the fields defined in this collection will have no effect on the display. The fields simply form a template that is used to define the contents of an Attribute Data report.

```
Usage (Character Attributes)
Collection (Logical)
    Usage (Char Attr Enhance)
    Usage (Char Attr Underline)
    Usage (Char Attr Blink)
    ReportSize (1)
    ReportCount (3)
    Feature (Const, var)
    ReportSize (5)
    ReportCount (1)
    Feature (Const) ; pad to byte boundary
End Collection ()
```

The following Character Report contains 2, 4 byte fields, one for character data and the other for character attributes. Each report allows 4 characters to be modified simultaneously.

```
Usage (Character Report)
Collection (Logical)
    ReportID (3)
    Usage (Display Data)
    ReportSize (8)
    ReportCount (4)
    Feature (Data, Variable, Absolute, Buffered Bytes), ;4-byte data buffer
    Usage (Attribute Data)
    ReportSize (8)
    ReportCount (4)
    Feature (Data, Variable, Absolute, Buffered Bytes), ;4-byte data buffer
End Collection ()
```

5.2 Bit-Addressable Display Support

The HID usage definitions provide little or no support for bit-addressable displays. As this type of display comes into wider usage this lack of support will become a serious problem. Parties interested in using this type of display should begin now to work through the USBIF HID working group to develop support for this type of display.

6 Locally Generated Tones

The HID Telephony Device Page provides support for several locally generated tones. A compliant device can generate these tones in response to HID requests as opposed to

having the PC deliver these tones to the device through the audio stream. The supported tones are:

<i>Inside Dial Tone:</i>	A tone that indicates to the user that the telephone is ready to place an inside call.
<i>Outside Dial Tone:</i>	A tone that indicates to the user that the telephone is ready to place an outside call.
<i>Inside Ring Tone:</i>	An in-house destination telephone is ringing.
<i>Outside Ring Tone:</i>	An outside destination telephone is ringing.
<i>Priority Ring Tone:</i>	The tone generated while a destination telephone is ringing as the result of a programmable function (like autodial, etc).
<i>Inside Ringback:</i>	A ringback feature has been activated to an inside line. Ringback is a feature that a user could invoke when the destination is busy. Once the destination hangs up its current call, the destination's phone "places a call" to the original user.
<i>Outside Ringback:</i>	A ringback feature has been activated to an outside line.
<i>Priority Ringback:</i>	A priority ringback feature has been activated.
<i>Line Tone Busy:</i>	The destination line is currently busy.
<i>Reorder Tone:</i>	There are no lines available for the user to place the call.
<i>Call Waiting Tone:</i>	The user is currently on a line and another phone call is coming in.
<i>Confirmation Tone 1:</i>	A feature the user has requested has been enabled. This tone is generated while the user is programming the phone.
<i>Confirmation Tone 2:</i>	A feature the user has requested has been enabled. This tone is generated while the user is programming the phone.
<i>Ringer:</i>	An incoming call is available. This tone is generated while the phone is on-hook

With the exception of *Ringer*, all the HID tone controls are momentary controls. When the device receives a control request through a HID Output report, the specified tone is played once and stops. *Ringer* is an on-off control. The ringer tone must be generated as long as the control remains in the ON state. Host software must negate the control to stop the tone. This allows different ring patterns to be generated by the host software.

The HID Telephony Devices Page defines one additional control that relates to locally generated tones. This control is the *Tones Off* control. This is an on-off control that turns off all tones and negates all control values.

7 Additional Useful HID Telephony Controls

The HID Telephony Usages define several other controls that can be used to add features and value to a USB telephony device.

<i>Flash:</i>	Generates a momentary On-Hook condition to signal host software. This control is often used for alternate line selection.
---------------	---

<i>Hold:</i>	Places the current call on hold.
<i>Redial:</i>	Redials the last number dialed.
<i>Transfer:</i>	Transfers the call to another extension.
<i>Drop:</i>	Disconnects the active call.
<i>Park:</i>	Waits for a free line.
<i>Forward Calls:</i>	Forwards calls to another number.
<i>Line:</i>	Allows line selection from multiple lines.
<i>Conference:</i>	Initiates a conference call.
<i>Ring Select:</i>	Selects a ring tone. Typically, the caller presses Ring Select, then presses a dial digit to select the tone.
<i>Caller ID:</i>	Displays the ID of the caller.
<i>Send:</i>	This indicates that the user has completed entering digits and is ready to begin routing the call.
<i>Do Not Disturb:</i>	Disables ring and speaker phone operation and forwards calls to a voice mail application.

8 HID App-Launch and App-defined Controls

Two areas of HID extensibility for USB telephony devices are application launch controls and application-defined controls. The launch controls provide the device with a means for starting a specific application or type of application on the host computer. Application-defined controls are buttons that do not have a specific system-wide meaning or use. Instead, the purpose of the button may change from application to application.

The Consumer Usages Page defines several usages for launching specific applications. Of particular interest to telephony devices are the buttons defined to launch voice mail and telephony/dialer applications. The following example shows a HID collection containing both these buttons.

```

Usage Page (Telephony Device)
Usage (Phone)
Collection (Application)
...
UsagePage (Consumer)
Usage (Application Launch Buttons)
Collection (Logical)
    Logical Minimum (0)
    Logical Maximum (1)
    Report Size (1)
    Report Count (1)
    Usage (AL Voicemail)
    Input (Data, Array, Abs)
    Usage (AL Telephony/Dialer)
    Input (Data, Array, Abs)
End Collection ()
...
End Collection ()

```

The Telephony Device Usage Page defines a usage for programmable buttons. This usage is ideal for implementing application-defined buttons. The following example shows a HID collection for a device with 6 programmable buttons. When one of the buttons is pressed, the device reports the 1-based numeric ID of the button pressed.

```
Usage Page (Telephony Device)
Usage (Phone)
Collection (Application)
...
Usage (Programmable Buttons)
Collection (Logical)
    Usage Page (Button)
    Usage Minimum (Button 1)
    Usage Maximum (Button 6)
    Report Count (1)
    Report Size (3)
    Logical Minimum (1)
    Logical Maximum (6)
    Input (Data, Array, Abs)
End Collection ()
...
End Collection ()
```

9 High-Fidelity Audio Quality

The basic handset model describes a device that operates with 16-bit mono PCM audio data at 16kHz and 8kHz sample rates. This is sufficient quality for telephony applications, but vendors can choose to design products that can serve other audio functions besides telephony. The other functions may require a higher quality data stream than that defined for the basic handset.

The basic handset uses two alternate settings for each audio streaming interface. For any isochronous device, the first alternate setting should always be the *zero-bandwidth* setting. This setting contains no endpoints and therefore, cannot consume USB bus bandwidth. The second alternate setting describes the telephony-quality setting. This setting supports a 16-bit mono stream with a sample rate of either the 8kHz or the 16kHz.

Additional sample rates and sample sizes other than 16-bit should be implemented by adding additional alternate settings to the audio streaming interface. An astute reader of the Audio Device Class specification will note that additional sampling rates can be added by modifying the Type I Data Format Descriptor in the telephony-quality alternate setting. This approach should not be used for the following reason:

Each alternate setting also contains an endpoint descriptor. This endpoint descriptor lists the maximum data packet size for the alternate setting. This value must be equal to or greater than the number of bytes the device receives at the highest listed sample rate. This can greatly impact allocation of USB bandwidth. If a vendor chooses to support 48kHz 16-bit mono as well as the standard telephony values by adding 48kHz to the telephony sample rates, the device would have to claim a maximum data packet size of 96 bytes (48 samples X 2-bytes per sample). The host then needs to reserve 96 bytes per frame of bandwidth for the stream even though telephony applications only use 32 bytes (16 samples X 2 bytes per sample) per frame. Defining an *additional* alternate setting (rather than extending the existing Type I Data Format Descriptor) allows the host to

reserve only the bandwidth that is needed to operate the device in the desired mode. The following examples illustrate how to modify the Type 1 Data Format Descriptor in the additional alternate setting to address high fidelity sample rates.

Additional sample rates can be added to a Type I Format Descriptor in one of two ways, depending on the audio silicon capabilities. Some devices provide a rate-adaptive render path. These devices do not provide a means of setting a sample rate frequency. Instead, the hardware distributes the samples received in one frame evenly across the next frame. This type of device does not list every sampling frequency it supports since the number of supported frequencies is infinite. Instead, it defines only a minimum and maximum sampling frequency as shown in Table 7.

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x00	Device is rate-adaptive
8	tSamFreq	3	0x01F40	8000Hz minimum sampling frequency
11	tSamFreq	3	0X0BB80	48000Hz maximum sampling frequency

Table 7: Type I Format Descriptor for Rate-adaptive devices

Alternatively, additional explicit sampling rates can be added to the Type I format descriptor as shown in Table 8. Either approach can be used for a rate-adaptive device, but only the second approach can be used for a non rate-adaptive device. The descriptor field *bSamFreqType* is used to indicate to the host which approach is used. If this field contains a value of 0, then the interface is rate-adaptive. Otherwise, the field contains the number of frequencies listed in the descriptor.

Offset	Field	Size	Value	Description
0	bLength	1	0x13	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x04	Device supports 4 sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz supported
11	tSamFreq	3	0X03E80	16000Hz supported
14	tSamFreq	3	0x0AC44	44100Hz supported
17	tSamFreq	3	0x0BB80	480000Hz supported

Table 8: Type I Format Descriptor for non rate-adaptive devices

10 Firmware upgrade

The USB Device Working Group has defined a means for upgrading device firmware in the field using USB as the command and transport mechanism. The definitions for upgrading firmware are found in the document titled *Universal Serial Bus Device Class Specification for Device Firmware Upgrade*. This document uses the acronym DFU for Device Firmware Upgrade. Implementing DFU is not trivial a trivial task.

Any device that supports this DFU model is required to define a DFU interface in each runtime configuration enumerated by the device. This interface is typically the last interface enumerated in each configuration. However, there is no requirement for this interface to occupy any specific position. The DFU interface uses only the default control endpoints and as such, can be represented by a single interface descriptor and a DFU functional descriptor.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	Number	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	Only the control endpoints are used
5	bInterfaceClass	1	0xFE	Application Specific Class Code
6	bInterfaceSubclass	1	0x01	Device Firmware Upgrade Code
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	Index	Index of string descriptor for this interface

Table 9: DFU Interface Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x21	DFU_FUNCTIONAL descriptor
2	bmAttributes	1	Number	DFU attributes b7:3 reserved b2 : device can communicate via USB after Manifestation Phase b1: Device can upload b0: Device can accept downloads
3	wDetachTimeOut	2	0x00	Time in milliseconds that the device will wait after receipt of the DFU_DETACH request. If this time elapses without a USB reset, the device will terminate the reconfiguration phase and revert back to normal operation.
4	wTransferSize	2	0x00	Only the control endpoints are used.

Table 10: DFU Functional Descriptor

In addition to the standard runtime descriptor set, a device must also support a DFU descriptor set. This descriptor set should consist of a Device Descriptor, a Configuration Descriptor, a single DFU interface descriptor, and a DFU Functional Descriptor. The Device Descriptor must have a *bDeviceClass* value of 0xFE and a *bDeviceSubClass* value of 0x01. The PID value of the DFU Device Descriptor must be different from the value in the runtime Device Descriptor for correct re-enumeration to occur.

Any device capable of supporting DFU must be able to maintain some amount of state information across USB Resets. To begin the DFU process, the host computer sends a DFU_DETACH command to the DFU interface as found in the runtime descriptor set. The host issues a USB Reset and re-enumerates the device. When the device detects the reset, it must change descriptor sets, making the DFU descriptor set the active descriptor set. When the host re-enumerates the device, the device returns the DFU descriptor set. The host then downloads the new firmware payload to the device and the device reprograms itself. The sequence ends with a second USB reset. This reset causes the device to use the new standard descriptor set as the active descriptor set.

11 References

- Universal Serial Bus specification, Versions 1.0 and 1.1, available at <http://www.usb.org>
- *Universal Serial Bus Device Class Definition for Audio Devices, Version 1.0*, available at <http://www.usb.org>
- *Universal Serial Bus Device Class Definition for Audio Data Formats, Version 1.0*, available at <http://www.usb.org>
- *Universal Serial Bus Device Class Definition for Terminal Types, Version 1.0*, available at <http://www.usb.org>
- *Universal Serial Bus Device Class Definitions for Communication Devices, Version 1.1*, available at <http://www.usb.org>

- *Universal Serial Bus Device Class Specification for Device Firmware Upgrade, Version 1.0, available at <http://www.usb.org>*
 - *Universal Serial Bus Device Class Definition for Human Interface Devices (HID), Versions 1.0 and 1.1, available at <http://www.usb.org>*
 - *Universal Serial Bus HID Usage Tables, Version 1.0 and 1.1, available at <http://www.usb.org>*
 - *Universal Serial Bus HID Usage Tables, Version 1.11rc1, available to USBIF members at <http://www.usb.org>*
 - *Support for USB Telephony Devices in Microsoft Windows, Version 0.92, available at <http://www.microsoft.com/hwdev/usb/USBtelephony.htm>*
-

Appendix A: Basic Handset Descriptors

This appendix lists the descriptors used to describe a Basic USB handset.

1.1 Device Descriptor

Each device contains one Device Descriptor. This descriptor describes general properties of the device. Implementers must change the *idVendor*, *idProduct*, and *bcdDevice* fields to values appropriate for a specific device. Use of string descriptor indices in the *iManufacturer*, *iProduct*, and *iSerialNumber* fields is recommended.

Offset	Field	Size	Value	Description
0	bLength	1	0x12	Size of this descriptor, in bytes
1	bDescriptorType	1	0x01	DEVICE descriptor
2	bcdUSB	2	0x0110	11 - current revision of USB spec
4	bDeviceClass	1	0x00	Device defined at Interface level
5	bDeviceSubClass	1	0x00	Unused
6	bDeviceProtocol	1	0x00	Unused
7	bMaxPacketSize0	1	0x08	8 bytes (typical – can be 8/16/32/64)
8	idVendor	2	0xFFFF	Vendor ID
10	idProduct	2	0xFFFF	Product ID
12	bcdDevice	2	0xFFFF	Device Release Code
14	iManufacturer	1	0x01	Index to the Manufacturer Name String descriptor
15	iProduct	1	0x02	Index to Product Name string descriptor
16	iSerialNumber	1	0x03	Index to Serial Number String descriptor This string is optional but is recommended because it helps the system track the telephone across reboots and removal/reinsertion
17	bNumConfigurations	1	0x01	One configuration

1.2 Configuration Descriptor

This device contains one Configuration Descriptor. This descriptor serves as a wrapper for all the other descriptors that apply to this configuration. These other descriptors include the interface, endpoint, and class-specific descriptors. Implementers must update the *wTotalLength* field to reflect the total size of this descriptor and all other descriptors that apply to this configuration. The *bmAttributes* and *bMaxPower* fields must also be updated to reflect the properties of the actual device.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x02	CONFIGURATION descriptor
2	wTotalLength	2	0x00XX	Length of the total configuration block, including this descriptor, in bytes
4	bNumInterfaces	1	0x04	Four interfaces
5	bConfigurationValue	1	0x01	ID of this configuration
6	iConfiguration	1	0x00	Unused
7	bmAttributes	1	0xA0	Bus Powered, Remote Wakeup capable
8	bMaxPower	1	0x32	A Reasonable Value:100 mA (2mA units)

1.3 Interface 0 Descriptors : Audio Control Interface

1.3.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x00	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints: uses control endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x01	AUDIO_CONTROL
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.3.2 Audio Device Class (AC) Header Descriptor

The AC-specific descriptors must always start with a Header Descriptor. The *wTotalLength* field must be updated to reflect the total size of all the Audio Device Class-specific descriptors contained in this interface.

Offset	Field	Size	Value	Description
0	bLength	1	0x0A	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x01	HEADER subtype
3	bcdADC	2	0x0100	Revision of class specification - 10
5	wTotalLength	2	0x00XX	Total size of class specific descriptors
7	bInCollection	1	0x02	Number of streaming interfaces
8	baInterfaceNr(1)	1	0x01	Audio Streaming interface 1 belongs to this Audio Control interface
9	baInterfaceNr(2)	1	0x02	Audio Streaming interface 2 belongs to this Audio Control interface

1.3.3 AC Input Terminal Descriptor (ID 1, USB Streaming OUT)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x01	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming Out
6	bAssocTerminal	1	0x00	No Association
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.3.4 AC Input Terminal Descriptor (ID 2, Handset Microphone)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x02	ID of this Terminal
4	wTerminalType	2	0x0401	Terminal is Handset Microphone
6	bAssocTerminal	1	0x05	Associated with Handset Speaker
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.3.5 Feature Unit Descriptor (ID 3)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bUnitID	1	0x03	ID of this Feature Unit
4	bSourceID	1	0x01	From USB Streaming OUT Terminal
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x03	Volume and Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.3.6 Feature Unit Descriptor (ID 4)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bUnitID	1	0x04	ID of this Feature Unit
4	bSourceID	1	0x02	From Handset Microphone
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x01	Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.3.7 AC Output Terminal Descriptor (ID 5, Handset Speaker)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x05	ID of this Terminal
4	wTerminalType	2	0x0401	Terminal is Handset Speaker
6	bAssocTerminal	1	0x02	Associated with Handset Microphone
7	bSourceID	1	0x03	From Feature Unit (ID 3)
8	iTerminal	1	0x00	Unused

1.3.8 AC Output Terminal Descriptor (ID 6, USB Streaming IN)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x06	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming IN
6	bAssocTerminal	1	0x01	No Association
7	bSourceID	1	0x04	From Feature Unit (ID 4)
8	iTerminal	1	0x00	Unused

1.4 Interface 1 Descriptors: Audio Streaming OUT Interface

1.4.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.4.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.4.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x01	Linked to USB Streaming OUT Terminal
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.4.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz Required sampling frequency
11	tSamFreq	3	0X03E80	16000Hz Encouraged sampling frequency

1.4.5 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x01	OUT Endpoint 1
3	bmAttributes	1	0x09	Adaptive Isochronous
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.4.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device specific for adaptive devices
5	wLockDelay	2	0XXXXX	Device Specific

1.5 Interface 2 Descriptors: Audio Streaming IN Interface

1.5.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x02	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.5.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x02	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.5.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x06	USB Streaming IN Terminal
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.5.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz required sampling frequency
11	tSamFreq	3	0x03E80	16000Hz encouraged sampling frequency

1.5.5 Endpoint descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x82	IN Endpoint 2
3	bmAttributes	1	0x09	Adaptive Isochronous
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.5.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xFF	Device Specific
5	wLockDelay	2	0xFFFF	Device Specific

1.6 Interface 3 Descriptors: HID Interface

1.6.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x03	HID
6	bInterfaceSubclass	1	0x00	Not a boot device
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.6.2 HID Class Descriptor

The field *wDescriptorLength* must be updated to reflect the total size of the HID Report Descriptor.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Total size of the HID device descriptor
1	bDescriptorType	1	0x21	HID Descriptor type
2	bcdHID	2	0x0100	HID Class Specification release 100
4	bCountryCode	1	0x00	Not localized for any country
5	bNumDescriptors	1	0x01	1 class descriptor
6	bDescriptorType	1	0x22	Report Descriptor type
7	wDescriptorLength	2	0xFF	Total size of the Report descriptor

1.6.3 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x83	IN Endpoint 3
3	bmAttributes	1	0x03	Interrupt
4	wMaxPacketSize	2	0x0001	1 bytes
6	bInterval	1	0x0A	Poll at 10 msec intervals

1.7 HID Report Descriptor

As is customary for HID report descriptors, the contents of the report descriptor are described here in a readable notation that can be readily assembled into binary form.

```

UsagePage(Telephony Devices)          05 0B
Usage (Phone)                          09 01
Collection (Application)               A1 01
;
; Key pad – The input report contains one 4-bit item that returns the 1-based index of the current key being
;           pressed or 0 for no keys pressed. An index value of 1 maps to the key described by the
;           Usage Minimum, hence, Phone Key 0
;
Usage (Telephony Key Pad)               09 06
Collection (Logical)                   A1 02
    Usage Minimum (Phone Key 0)         19 B0
    Usage Maximum (Phone Key Pound)     29 BB
    Logical Minimum (0)                 15 00
    Logical Maximum (12)                25 0C
    ReportSize (4)                      75 04
    ReportCount (1)                     95 01
    Input (Data, Array, Abs)            81 00
End Collection()                       C0
;
; Volume – The input report contains one 2-bit item that returns a desired relative volume change
;
Usage (Handset)                        09 04
Collection (Logical)                   A1 02
    Usage Page (Consumer Devices)       05 0C
    Usage (Volume)                      09 E0
    Logical Minimum(-1)                 15 FF
    Logical Maximum(1)                  25 01
    ReportSize(2)                       75 02
    ReportCount(1)                      95 01
    Input(Data, Var, Rel)               81 06
End Collection()                       C0
;
; Buttons – This section creates a Hook Switch item. This item is a 1-bit item and is present in
;           in both the Input and Feature reports
;
Logical Minimum(0)                     15 00
Logical Maximum(1)                     25 01
ReportSize(1)                          75 01
ReportCount(1)                         95 01
Usage(Hook Switch)                     09 20

```

Input (Data, Var, Abs)	81 02
Usage(Hook Switch)	09 20
Feature (Data, Var, Abs)	B1 02
;	
; Padding – This section is used to pad all reports to byte boundaries.	
;	1 bit is needed for the Input report, 7 bits are needed for the Feature report.
;	
ReportSize(1)	75 01
ReportCount(1)	95 01
Input (Cnst, Var, Abs)	81 03
ReportSize(7)	75 07
Feature (Cnst, Var, Abs)	B1 03
End Collection()	C0

Appendix B: Speakerphone Descriptors

This appendix lists the descriptors for a Basic USB handset that has added speakerphone functionality. The phone has mute and speakerphone buttons. It also has two LEDs that indicate the current state of these buttons to the user.

1

1.1 Device Descriptor

Each device contains one Device Descriptor. This descriptor describes general properties of the device. Implementers must change the *idVendor*, *idProduct*, and *bcdDevice* fields to values appropriate for a specific device. Use of string descriptor indices in the *iManufacturer*, *iProduct*, and *iSerialNumber* fields is recommended.

Offset	Field	Size	Value	Description
0	bLength	1	0x12	Size of this descriptor, in bytes
1	bDescriptorType	1	0x01	DEVICE descriptor
2	bcdUSB	2	0x0110	1.1 - current revision of USB spec
4	bDeviceClass	1	0x00	Device defined at Interface level
5	bDeviceSubClass	1	0x00	Unused
6	bDeviceProtocol	1	0x00	Unused
7	bMaxPacketSize0	1	0x08	8 bytes (typical)
8	idVendor	2	0xFFFF	Vendor ID
10	idProduct	2	0xFFFF	Product ID
12	bcdDevice	2	0xFFFF	Device Release Code
14	iManufacturer	1	0x01	Index to the Manufacturer Name String descriptor
15	iProduct	1	0x02	Index to Product Name string descriptor
16	iSerialNumber	1	0x03	Index to Serial Number String descriptor This string is optional but is recommended because it helps the system track the telephone across reboots and removal/reinsertion
17	bNumConfigurations	1	0x01	One configuration

1.2 Configuration Descriptor

This device contains one Configuration Descriptor. This descriptor serves as a wrapper for all the other descriptors that apply to this configuration. These other descriptors include the interface, endpoint, and class-specific descriptors. Implementers must update the *wTotalLength* field to reflect the total size of this descriptor and all other descriptors that apply to this configuration. The *bmAttributes* and *bMaxPower* fields must also be updated to reflect the properties of the actual device.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x02	CONFIGURATION descriptor
2	wTotalLength	2	0x00XX	Length of the total configuration block, including this descriptor, in bytes
4	bNumInterfaces	1	0x04	Four interfaces
5	bConfigurationValue	1	0x01	ID of this configuration
6	iConfiguration	1	0x00	Unused
7	bmAttributes	1	0xA0	Bus Powered, Remote Wakeup capable
8	bMaxPower	1	0x32	A Reasonable Value (100 mA)

1.3 Interface 0 Descriptors : Audio Control Interface

1.3.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x00	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints: uses control endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x01	AUDIO_CONTROL
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.3.2 Audio Device Class (AC) Header Descriptor

The AC-specific descriptors must always start with a Header Descriptor. The *wTotalLength* field must be updated to reflect the total size of all the Audio Device Class-specific descriptors contained in this interface.

Offset	Field	Size	Value	Description
0	bLength	1	0x0A	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x01	HEADER subtype
3	bcdADC	2	0x0100	Revision of class specification - 10
5	wTotalLength	2	0x00XX	Total size of class specific descriptors
7	bInCollection	1	0x02	Number of streaming interfaces
8	baInterfaceNr(1)	1	0x01	Audio Streaming interface 1 belongs to this Audio Control interface
9	baInterfaceNr(2)	1	0x02	Audio Streaming interface 2 belongs to this Audio Control interface

1.3.3 AC Input Terminal Descriptor (ID 1, USB Streaming OUT)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x01	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming Out
6	bAssocTerminal	1	0x00	No Association
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.3.4 AC Input Terminal Descriptor (ID 2, Speakerphone Microphone)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x02	ID of this Terminal
4	wTerminalType	2	0x0405	Terminal is AEC Speakerphone
6	bAssocTerminal	1	0x09	Associated with Speakerphone speaker
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.3.5 AC Input Terminal Descriptor (ID 3, Handset Microphone)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x03	ID of this Terminal
4	wTerminalType	2	0x0401	Terminal is Handset Microphone
6	bAssocTerminal	1	0x08	Associated with Handset Out Terminal
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.3.6 Selector Unit Descriptor (ID 4)

Offset	Field	Size	Value	Description
0	bLength	1	0x08	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x05	SELECTOR_UNIT subtype
3	bUnitID	1	0x04	ID of this Feature Unit
4	bNrInPins	1	0x02	Two input pins
5	baSourceID (1)	1	0x02	From Speakerphone Microphone (ID 2)
6	baSourceID (2)	1	0x03	From Handset Microphone (ID 3)
7	iSelector	1	0x00	Unused

1.3.7 Feature Unit Descriptor (ID 5)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x05	ID of this Feature Unit
4	bSourceID	1	0x01	From USB Streaming OUT (ID 1)
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x03	Volume and Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.3.8 Feature Unit Descriptor (ID 6)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x06	ID of this Feature Unit
4	bSourceID	1	0x01	From USB Streaming OUT (ID 1)
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x03	Volume and Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.3.9 Feature Unit Descriptor (ID 7)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x07	ID of this Feature Unit
4	bSourceID	1	0x04	From Selector Unit (ID 4)
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x01	Only Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.3.10 AC Output Terminal Descriptor (ID 8, Handset Speaker)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x08	ID of this Terminal
4	wTerminalType	2	0x0401	Terminal is Handset Speaker
6	bAssocTerminal	1	0x03	Associated with Handset In Terminal
7	bSourceID	1	0x05	From Feature Unit (ID 5)
8	iTerminal	1	0x00	Unused

1.3.11 AC Output Terminal Descriptor (ID 9, Speakerphone Speaker)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x09	ID of this Terminal
4	wTerminalType	2	0x0405	Terminal is AEC Speakerphone
6	bAssocTerminal	1	0x02	Associated with Speakerphone Mic
7	bSourceID	1	0x06	From Feature Unit (ID 6)
8	iTerminal	1	0x00	Unused

1.3.12 AC Output Terminal Descriptor (ID 10, USB Streaming IN)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x0A	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming IN
6	bAssocTerminal	1	0x00	No Association
7	bSourceID	1	0x07	From Feature Unit (ID 7)
8	iTerminal	1	0x00	Unused

1.4 Interface 1 Descriptors: Audio Streaming OUT Interface

1.4.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.4.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.4.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x01	Linked to USB Streaming OUT Terminal
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.4.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz Required sampling frequency
11	tSamFreq	3	0X03E80	16000Hz Encouraged sampling frequency

1.4.5 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x01	OUT Endpoint 1
3	bmAttributes	1	0x09	Adaptive Isochronous
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.4.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device specific for adaptive devices
5	wLockDelay	2	0xFFFF	Device Specific

1.5 Interface 2 Descriptors: Audio Streaming IN Interface

1.5.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x02	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.5.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x02	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.5.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x0A	USB Streaming IN Terminal
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.5.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz required sampling frequency
11	tSamFreq	3	0x03E80	16000Hz encouraged sampling frequency

1.5.5 Endpoint descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x82	IN Endpoint 2
3	bmAttributes	1	0x09	Adaptive Isochronous
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.5.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device Specific
5	wLockDelay	2	0xFFFF	Device Specific

1.6 Interface 3 Descriptors: HID Interface

1.6.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x03	HID
6	bInterfaceSubclass	1	0x00	Not a boot device
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.6.2 HID Class Descriptor

The field *wDescriptorLength* must be updated to reflect the total size of the HID Report Descriptor.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Total size of the HID device descriptor
1	bDescriptorType	1	0x21	HID Descriptor type
2	bcdHID	2	0x0100	HID Class Specification release 100
4	bCountryCode	1	0x00	Not localized for any country
5	bNumDescriptors	1	0x01	1 class descriptor
6	bDescriptorType	1	0x22	Report Descriptor type
7	wDescriptorLength	2	0xXX	Total size of the Report descriptor

1.6.3 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x83	IN Endpoint 3
3	bmAttributes	1	0x03	Interrupt
4	wMaxPacketSize	2	0x0001	1 bytes
6	bInterval	1	0x0A	Poll at 10 msec intervals

1.7 HID Report Descriptor

As is customary for HID report descriptors, the contents of the report descriptor are described here in a readable notation that can be readily assembled into binary form.

```

Usage Page (Telephony Devices)          05 0B
Usage (Phone)                           09 01
Collection (Application)                 A1 01
;
; Key pad – The input report contains one 4-bit item that returns the 1-based index of the current key being
;           pressed or 0 for no keys pressed. An index value of 1 maps to the key described by the
;           Usage Minimum, hence, Phone Key 0
;
Usage (Telephony Key Pad)                 09 06
Collection (Logical)                     A1 02
    Usage Minimum (Phone Key 0)           19 B0
    Usage Maximum (Phone Key Pound)       29 BB
    Logical Minimum (0)                   15 00
    Logical Maximum (12)                  25 0C
    Report Size (4)                       75 04
    Report Count (1)                      95 01
    Input (Data, Array, Abs)              81 00
End Collection ()                         C0
;
; Volume – The input report contains one 2-bit item that returns a desired relative volume change
;
Usage (Phone)                           09 04
Collection (Logical)                     A1 02

```

```

        Usage Page (Consumer Devices)          05 0C
        Usage (Volume)                          09 E0
        Logical Minimum(-1)                    15 FF
        Logical Maximum(1)                     25 01
        Report Size(2)                          75 02
        Report Count(1)                        95 01
        Input(Data, Var, Rel)                   81 06
    End Collection ()                           C0
;
; Buttons – This section creates a Hook Switch item, a Speakerphone item, and a Phone Mute button. All
;           three items are 1-bit items and are present both the Input and Feature reports.
;
;
    Logical Minimum (0)                        15 00
    Logical Maximum (1)                       25 01
    Report Size (1)                           75 01
    Report Count (1)                          95 01
    Usage (Hook Switch)                       09 20
    Input (Data, Var, Abs)                     81 02
    Usage (Hook Switch)                       09 20
    Feature (Data, Var, Abs)                   B1 02
    Usage (Speaker Phone)                     09 2B
    Input (Data, Var, Abs)                     81 02
    Usage (Speaker Phone)                     09 2B
    Feature (Data, Var, Abs)                   B1 02
    Usage (Phone Mute)                        09 2F
    Input (Data, Var, Abs)                     81 02
    Usage (Phone Mute)                        09 2F
    Feature (Data, Var, Abs)                   B1 02
;
; LED Indicators – The output report supports two “in-use” indicators, one for the Speakerphone button
;                  and one for the mute button.
;
;
    Usage Page (LED)                          05 08
    Logical Minimum(0)                        15 00
    Logical Maximum(1)                       25 01
    ReportSize(1)                             75 01
    ReportCount(1)                            95 01
    Usage (Usage Selected Indicator)           09 3A
    Collection (Logical)                       A1 02
        Usage Page (Telephony Devices)        05 0B
        Usage (Speaker Phone)                  09 2B
        Output (Data, Var, Abs)                 91 02
        Usage (Phone Mute)                     09 2F
        Output (Data, Var, Abs)                 91 02
    End Collection ()                           C0
;
; Padding – This section is used to pad all reports to byte boundaries. 7 bits are needed for the Input
;           report, 5 bits for the Feature report, and 6 bits for the Output report.
;
;
    Report Count (1)                          95 01
    Report Size (7)                           75 07
    Input (Cnst, Var, Abs)                     81 03
    Report Size (5)                           95 05
    Feature (Cnst, Var, Abs)                   B1 03
    Report Size (6)                           75 06
    Output (Cnst, Var, Abs)                    91 03
End Collection()                              C0

```

Appendix C: Descriptors for PSTN Handset

This section lists the USB descriptors for a Telephone Control Model implementation of a PSTN-enabled handset.

1 Empty Heading

1.1 Device Descriptor

Each device contains one Device Descriptor. This descriptor describes general properties of the device. Implementers must change the *idVendor*, *idProduct*, and *bcdDevice* fields to values appropriate for a specific device. Use of string descriptor indices in the *iManufacturer*, *iProduct*, and *iSerialNumber* fields is recommended.

The Device Descriptor header presented here differs from the CDC Device Descriptor requirements in that CDC support is not declared at the device level. Since the device does not contain any CDC Data Class interfaces, device level CDC enumeration should not be required.

Offset	Field	Size	Value	Description
0	bLength	1	0x12	Size of this descriptor, in bytes
1	bDescriptorType	1	0x01	DEVICE descriptor
2	bcdUSB	2	0x0110	1.1 – current revision of USB spec
4	bDeviceClass	1	0x00	Device defined at Interface level
5	bDeviceSubClass	1	0x00	Unused
6	bDeviceProtocol	1	0x00	Unused
7	bMaxPacketSize0	1	0x08	8 bytes typical
8	idVendor	2	0xFFFF	Vendor ID
10	idProduct	2	0xFFFF	Product ID
12	bcdDevice	2	0xFFFF	Device Release Code
14	iManufacturer	1	0x01	Index to the Manufacturer Name String descriptor
15	iProduct	1	0x02	Index to Product Name string descriptor
16	iSerialNumber	1	0x03	Index to Serial Number String descriptor This string is optional but is recommended because it helps the system track the telephone across reboots and removal/reinsertion
17	bNumConfigurations	1	0x01	One configuration

1.2 Configuration Descriptor

This device contains one Configuration Descriptor. This descriptor serves as a wrapper for all the other descriptors that apply to this configuration. These other descriptors include the interface, endpoint, and class-specific descriptors. Implementers must update

the *wTotalLength* field to reflect the total size of this descriptor and all other descriptors that apply to this configuration. The *bmAttributes* and *bMaxPower* fields must also be updated to reflect the properties of the actual device.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x02	CONFIGURATION descriptor
2	wTotalLength	2	0x00XX	Length of the total configuration block, including this descriptor, in bytes
4	bNumInterfaces	1	0x07	Seven interfaces
5	bConfigurationValue	1	0x01	ID of this configuration
6	IConfiguration	1	0x00	Unused
7	bmAttributes	1	0xA0	Bus Powered, Remote Wakeup capable
8	bMaxPower	1	0x32	Some Reasonable Value (100 mA)

1.3 Interface 0 Descriptors : CDC Control Interface

1.3.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints: uses control endpoints
5	bInterfaceClass	1	0x02	CDC
6	bInterfaceSubclass	1	0x03	Telephone Control Model
7	bInterfaceProtocol	1	0x00	No class specific protocol required
8	iInterface	1	0x00	Unused

1.3.2 CDC Header Functional Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x05	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bDescriptorSubtype	1	0x00	Header Functional Descriptor
3	bcdCDC	2	0x0101	CDC spec release number in BCD format

1.3.3 CDC Call Management Functional Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x05	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	Call Management Functional Descriptor
3	bmCapabilities	1	0x01	Device can do call management
4	bDataInterface	1	0x00	Unused

1.3.4 CDC Telephone Ringer Functional Descriptor

The values listed for the *bRingerVolSteps* and *bNumRingerPatterns* are not requirements and should be modified for a particular device's capabilities.

Offset	Field	Size	Value	Description
0	bLength	1	0x05	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bDescriptorSubtype	1	0x04	Telephone Ringer Functional Descriptor
3	bRingerVolSteps	1	0x01	fixed volume (On/Off only)
4	bNumRingerPatterns	1	0x01	one pattern only

1.3.5 CDC Telephone Operational Modes Functional Descriptor

The value listed for the field *bmCapabilities* is optional and should be adjusted for specific implementations.

Offset	Field	Size	Value	Description
0	bLength	1	0x04	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bDescriptorSubtype	1	0x08	Telephone Operational Modes Functional Descriptor
3	bmCapabilities	1	0x07	Supports all operational modes

1.3.6 CDC Telephone Call State Reporting Capabilities Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bDescriptorSubtype	1	0x05	Telephone Call State Reporting Capabilities Descriptor
3	bmCapabilities	4	0x0020	Line state change notification

1.3.7 CDC Union Functional Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x06	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bDescriptorSubtype	1	0x06	Union Functional Descriptor
3	bMasterInterface	1	0x01	This interface is master
4	bSlaveInterface (0)	1	0x02	slave 0 is the USB Audio Control Interface
5	bSlaveInterface (1)	1	0x03	slave 1 is USB Audio Streaming OUT to PSTN DAA
6	bSlaveInterface (2)	1	0x04	slave 2 is USB Audio Streaming IN from PSTN DAA

1.3.8 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x81	IN Endpoint 1
3	bmAttributes	1	0x03	Interrupt
4	wMaxPacketSize	2	0x0001	1 bytes
6	bInterval	1	0x0A	Poll at 10 msec intervals

1.4 Interface 1 Descriptors : Audio Control Interface

1.4.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x01	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints: uses control endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x01	AUDIO_CONTROL
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.4.2 Audio Device Class (AC) Header Descriptor

The AC-specific descriptors must always start with a Header Descriptor. The *wTotalLength* field must be updated to reflect the total size of all the Audio Device Class-specific descriptors contained in this interface.

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x01	HEADER subtype
3	bcdADC	2	0x0100	Revision of class specification - 10
5	wTotalLength	2	0x00XX	Total size of class specific descriptors
7	bInCollection	1	0x02	Number of streaming interfaces
8	baInterfaceNr(1)	1	0x02	Audio Streaming interface 1 (stream to speaker)
9	baInterfaceNr(2)	1	0x03	Audio Streaming interface 2 (stream from microphone)
10	baInterfaceNr(3)	1	0x04	Audio Streaming interface 3 (stream to PSTN)
11	baInterfaceNr(4)	1	0x05	Audio Streaming interface 4 (stream from PSTN)

1.4.3 AC Input Terminal Descriptor (ID 1, USB Streaming OUT #1)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x01	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming Out
6	bAssocTerminal	1	0x00	No Association
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.4.4 AC Input Terminal Descriptor (ID 2, Handset Microphone)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x02	ID of this Terminal
4	wTerminalType	2	0x0401	Terminal is Handset Microphone
6	bAssocTerminal	1	0x0B	Associated with Handset Speaker
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.4.5 AC Input Terminal Descriptor (ID 3, USB Streaming OUT #2)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x03	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming Out
6	bAssocTerminal	1	0x00	No Association
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.4.6 AC Input Terminal Descriptor (ID 4, PSTN IN)

Offset	Field	Size	Value	Description
0	bLength	1	0x0C	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	INPUT_TERMINAL subtype
3	bTerminalID	1	0x04	ID of this Terminal
4	wTerminalType	2	0x0501	Terminal is Phone Line
6	bAssocTerminal	1	0x0D	Associated with PSTN OUT
7	bNrChannels	1	0x01	One channel
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

1.4.7 Feature Unit Descriptor (ID 5)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x05	ID of this Feature Unit
4	bSourceID	1	0x01	From USB OUT #1
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x03	Volume and Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.4.8 Feature Unit Descriptor (ID 6)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x06	ID of this Feature Unit
4	bSourceID	1	0x03	From USB Streaming OUT (ID 3)
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x01	Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.4.9 Feature Unit Descriptor (ID 7)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x07	ID of this Feature Unit
4	bSourceID	1	0x03	From USB Streaming OUT (ID 3)
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x03	Volume and Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.4.10 Feature Unit Descriptor (ID 8)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x06	FEATURE_UNIT subtype
3	bUnitID	1	0x08	ID of this Feature Unit
4	bSourceID	1	0x03	From USB Streaming OUT (ID 3)
5	bControlSize	1	0x01	One byte control array
6	bmaControls(0)	1	0x01	Mute Supported
7	bmaControls(1)	1	0x00	Only Master Control Supported
8	iFeature	1	0x00	Unused

1.4.11 Selector Unit Descriptor (ID 9)

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x05	SELECTOR_UNIT subtype
3	bUnitID	1	0x09	ID of this Selector Unit
4	bNrInPins	1	0x02	two input pins
4	bSourceID (1)	1	0x05	From Feature Unit (ID 5)
5	bSourceID (2)	1	0x08	From Feature Unit (ID 8)
6	iFeature	1	0x00	Unused

1.4.12 Selector Unit Descriptor (ID 10)

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x05	SELECTOR_UNIT subtype
3	bUnitID	1	0x0A	ID of this Selector Unit
4	bNrInPins	1	0x02	two input pins
4	bSourceID (1)	1	0x06	From Feature Unit (ID 6)
5	bSourceID (2)	1	0x07	From Feature Unit (ID 7)
6	iFeature	1	0x00	Unused

1.4.13 AC Output Terminal Descriptor (ID 11, Handset Speaker)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x0B	ID of this Terminal
4	wTerminalType	2	0x0401	Terminal is Handset Speaker
6	bAssocTerminal	1	0x02	Associated with Handset Microphone
7	bSourceID	1	0x09	From Selector Unit (ID 9)
8	iTerminal	1	0x00	Unused

1.4.14 AC Output Terminal Descriptor (ID 12, USB Streaming IN #1)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x0C	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming IN
6	bAssocTerminal	1	0x00	No Association
7	bSourceID	1	0x06	From Feature Unit (ID 6)
8	iTerminal	1	0x00	Unused

1.4.15 AC Output Terminal Descriptor (ID 13, PSTN OUT)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x0D	ID of this Terminal
4	wTerminalType	2	0x0501	Terminal is Phone Line
6	bAssocTerminal	1	0x04	Associated with PSTN IN terminal
7	bSourceID	1	0x0A	From Selector Unit (ID 10)
8	iTerminal	1	0x00	Unused

1.4.16 AC Output Terminal Descriptor (ID 14, USB Streaming IN #2)

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x03	OUTPUT_TERMINAL subtype
3	bTerminalID	1	0x0E	ID of this Terminal
4	wTerminalType	2	0x0101	Terminal is USB Streaming IN #1
6	bAssocTerminal	1	0x00	No Association
7	bSourceID	1	0x08	From Feature Unit (ID 8)
8	iTerminal	1	0x00	Unused

1.5 Interface 2 Descriptors: Audio Streaming OUT Interface #1

This interface delivers audio data from the PC to the handset speaker.

1.5.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x02	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.5.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x02	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.5.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x01	USB Streaming OUT Terminal (ID 1)
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.5.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz Required sampling frequency
11	tSamFreq	3	0X03E80	16000Hz Encouraged sampling frequency

1.5.5 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x02	OUT Endpoint 2
3	bmAttributes	1	0x09	Adaptive Isochronous is preferred
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.5.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device specific for adaptive devices
5	wLockDelay	2	0xXXXX	Device Specific

1.6 Interface 3 Descriptors: Audio Streaming IN Interface #1

This interface delivers audio data from the handset microphone to the PC.

1.6.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x03	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.6.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x03	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.6.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x0C	USB Streaming IN Terminal (ID 12)
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.6.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz required sampling frequency
11	tSamFreq	3	0x03E80	16000Hz encouraged sampling frequency

1.6.5 Endpoint descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x83	IN Endpoint 3
3	bmAttributes	1	0x09	Adaptive Isochronous
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.6.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device Specific
5	wLockDelay	2	0xFFFF	Device Specific

1.7 Interface 4 Descriptors: Audio Streaming OUT Interface #2

This interface delivers audio data from the PC to the PSTN DAA components.

1.7.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x04	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.7.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x04	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.7.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x03	USB Streaming OUT Terminal (ID 3)
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.7.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz Required sampling frequency
11	tSamFreq	3	0X03E80	16000Hz Encouraged sampling frequency

1.7.5 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x04	OUT Endpoint 4
3	bmAttributes	1	0x09	Adaptive Isochronous is preferred
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.7.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device specific for adaptive devices
5	wLockDelay	2	0xXXXX	Device Specific

1.8 Interface 5 Descriptors: Audio Streaming IN Interface #1

This interface delivers audio data from the PSTN DAA component to the PC.

1.8.1 Alternate Setting 0 Descriptor: zero bandwidth setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x05	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x00	0 endpoints
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.8.2 Alternate Setting 1 Descriptor: operational setting

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x05	Index of this interface
3	bAlternateSetting	1	0x01	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.8.3 Audio Streaming General Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE descriptor
2	bDescriptorSubtype	1	0x01	GENERAL
3	bTerminalLink	1	0x0E	USB Streaming IN Terminal (ID 14)
4	bDelay	1	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM format

1.8.4 Audio Streaming Format Type Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x0E	Size of this descriptor, in bytes
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x02	FORMAT_TYPE
3	bFormatType	1	0x01	FORMAT_TYPE_I
4	bNrChannels	1	0x01	One channel
5	bSubFrameSize	1	0x02	Two bytes per slot
6	bBitResolution	1	0x10	16 bits
7	bSamFreqType	1	0x02	Two sampling frequencies
8	tSamFreq	3	0x01F40	8000Hz required sampling frequency
11	tSamFreq	3	0x03E80	16000Hz encouraged sampling frequency

1.8.5 Endpoint descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x85	IN Endpoint 5
3	bmAttributes	1	0x09	Adaptive Isochronous
4	wMaxPacketSize	2	0x0022	34 bytes per packet
6	bInterval	1	0x01	One packet every frame
7	bRefresh	1	0x00	Unused
8	bSynchAddress	1	0x00	Unused

1.8.6 Audio Device Class Endpoint General Descriptor

The fields *bLockDelayUnits* and *wLockDelay* together describe the amount of time required for a rate-adaptive device to reliably lock its internal clock recovery circuit. These fields must be updated to reflect the properties of the particular silicon used in the device.

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x25	CS_ENDPOINT
2	bDescriptorSubtype	1	0x01	GENERAL
3	bmAttributes	1	0x01	Sampling frequency control, no pitch control
4	bLockDelayUnits	1	0xXX	Device Specific
5	wLockDelay	2	0xFFFF	Device Specific

1.9 Interface 6 Descriptors: HID Interface

1.9.1 Alternate Setting 0 Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor, in bytes
1	bDescriptorType	1	0x04	INTERFACE descriptor
2	bInterfaceNumber	1	0x06	Index of this interface
3	bAlternateSetting	1	0x00	Index of this setting
4	bNumEndpoints	1	0x01	1 endpoint
5	bInterfaceClass	1	0x03	HID
6	bInterfaceSubclass	1	0x00	Not a boot device
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	Unused

1.9.2 HID Class Descriptor

The field *wDescriptorLength* must be updated to reflect the total size of the HID Report Descriptor.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Total size of the HID device descriptor
1	bDescriptorType	1	0x21	HID Descriptor type
2	bcdHID	2	0x0100	HID Class Specification release 100
4	bCountryCode	1	0x00	Not localized for any country
5	bNumDescriptors	1	0x01	1 class descriptor
6	bDescriptorType	1	0x22	Report Descriptor type
7	wDescriptorLength	2	0xXX	Total size of the Report descriptor

1.9.3 Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Size of this descriptor, in bytes
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bEndpointAddress	1	0x86	IN Endpoint 6
3	bmAttributes	1	0x03	Interrupt
4	wMaxPacketSize	2	0x0001	1 bytes
6	bInterval	1	0x0A	Poll at 10 msec intervals

1.10 HID Report Descriptor

As is customary for HID report descriptors, the contents of the report descriptor are described here in a readable notation that can be readily assembled into binary form.

UsagePage (Telephony Devices)	05 0B
Usage (Phone)	09 01
Collection (Application)	A1 01

```

;
; Key pad – The input report contains one 4-bit item that returns the 1-based index of the current key being
;           pressed or 0 for no keys pressed. An index value of 1 maps to the key described by the
;           Usage Minimum, hence, Phone Key 0
;
Usage (Telephony Key Pad)           09 06
Collection (Logical)                A1 02
    Usage Minimum (Phone Key 0)     19 B0
    Usage Maximum (Phone Key Pound) 29 BB
    Logical Minimum (0)             15 00
    Logical Maximum (12)            25 0C
    Report Size (4)                  75 04
    Report Count (1)                 95 01
    Input (Data, Array, Abs)        81 02
End Collection ()                   C0
;
; Volume – The input report contains one 2-bit item that returns a desired relative volume change
;
Usage (Handset)                     09 04
Collection (Logical)                A1 02
    Usage Page (Consumer Devices)   05 0C
    Usage (Volume)                  09 E0
    Logical Minimum(-1)             15 FF
    Logical Maximum(1)              25 01
    Report Size(2)                   75 02
    Report Count(1)                  95 01
    Input(Data, Var, Rel)           81 06
End Collection ()                   C0
;
; Buttons – This section creates a Hook Switch item. This item is a 1-bit item and is present in
;           in both the Input and Feature reports
;
Logical Minimum (0)                 15 00
Logical Maximum (1)                 25 01
Report Size (1)                     75 01
Report Count (1)                    95 01
Usage (Hook Switch)                 09 20
Input (Data, Var, Abs)              81 02
Usage (Hook Switch)                 09 20
Feature (Data, Var, Abs)            B1 02
;
; Padding – This section is used to pad all reports to byte boundaries.
;           1 bit is needed for the Input report, 7 bits are needed for the Feature report.
;
Report Size (1)                     75 01
Report Count (1)                    95 01
Input (Cnst, Var, Abs)              81 03
Report Size (7)                     75 07
Feature (Cnst, Var, Abs)            B1 03
End Collection()                    C0

```
